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Murray County, Oklahoma

National Eutrophication Survey, Las Vegas, Nev

Prepared for

Environmental Monitoring and Support Lab, Las Vegas, Nev

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NATIONAL EUTROPHICATION SURVEY

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and

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Report
on
Arbuckle Lake
Murray County
Oklahoma
EPA Region VI
Working Paper No. 582

With the cooperation of the
Oklahoma Department of Pollution Control
and the
Oklahoma National Guard
March, 1977

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT ON ARBUCKLE LAKE

MURRAY COUNTY, OKLAHOMA

EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 582

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

March 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Oklahoma Department of Pollution Control for professional involvement, to the Oklahoma National Guard for conducting the tributary sampling phase of the Survey, and to those Oklahoma wastewater treatment plant operators who provided effluent samples and flow data.

Dr. Denver Talley, Director, Oklahoma Department of Pollution Control; the staff of the Oklahoma Water Resources Board; and the staff of the Oklahoma State Department of Health reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

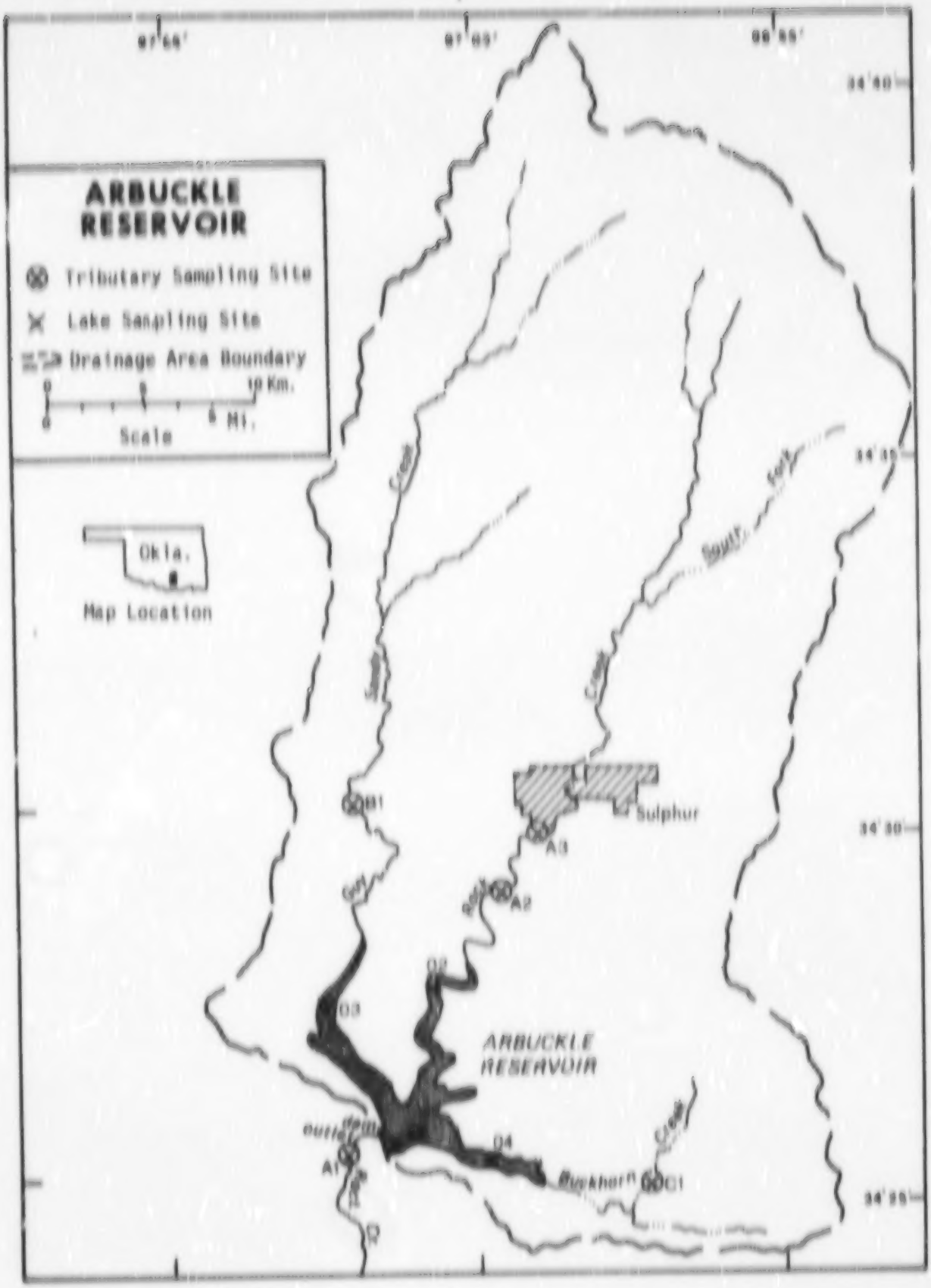
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis W. Milligan and Major James O. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OKLAHOMA

LAKE NAME	COUNTY
Altus Reservoir	Greer, Kiowa
Arbuckle Lake	Murray
Lake Elsworth	Caddo, Comanche
Lake Eufaula	Haskell, McIntosh, Okmulgee, Pittsburg
Fort Cobb Reservoir	Caddo
Fort Supply Reservoir	Woodward
Foss Dam Reservoir	Custer
Lake Frances	Adair
Grand Lake O' The Cherokees	Mayes, Delaware, Craig, Ottowa
Lake Hefner	Oklahoma
Keystone Reservoir	Tulsa, Creek, Osage, Pawnee
Oologah Lake	Nowata, Rogers
Tenkiller Ferry Reservoir	Cherokee, Sequoyah
Lake Thunderbird	Cleveland
Wister Reservoir	LeFlore


ARBUCKLE RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
10 Km.
5 Mi.
Scale
Okla.
Map Location
97°44'
97°33'
34°40'
34°35'
34°30'
34°25'
Sulphur
Buckhorn
ARBUCKLE RESERVOIR
A1
A2
A3
B1
C1
D1
D2
D3
D4

REPORT ON ARBUCKLE LAKE, OKLAHOMA

STORET NO. 4002

I. CONCLUSIONS

A. Trophic Condition:*

Arbuckle Lake is considered mesotrophic, based upon Survey data and field observations. Chlorophyll a values ranged from 2.3 µg/l in the summer to 12.5 µg/l in the spring, with a mean of 7.0 µg/l. Potential for primary production as measured by algal assay control yield was low. Of the 16 Oklahoma lakes (including Texoma Lake) sampled in 1974, 15 had higher median total phosphorus, 13 had higher median inorganic nitrogen, and 14 had higher median orthophosphorus levels than Arbuckle Lake.

Survey limnologists noted severe oxygen depression with depth at a number of the sampling stations during spring and summer visits to the lake, but did not observe any nuisance algal blooms or problem aquatic macrophytes.

*See Appendix E.

B. Rate-Limiting Nutrient:

Mean inorganic nitrogen to orthophosphorus (N/P) ratios in Arbuckle Lake indicate primary limitation by nitrogen in March and October, and phosphorus limitation during June. Algal assay results suggest the lake was limited by available phosphorus during the spring and autumn sampling seasons.

C. Nutrient Controllability:

1. Point sources -

No known municipal or industrial wastewater treatment plants impacted Arbuckle Lake during the sampling year. Two industrial plants (O.G. & E., and Kraft Foods) and one municipal plant in Sulphur are known to exist; however, their effluents are not discharged into Rock Creek and thus do not impact Arbuckle Reservoir. There is also a fish hatchery discharging into Buckhorn Creek, tributary C-1. Nutrient contributions from this source are not known.

The present phosphorus loading of 0.40 g $P/m^2/yr$ is slightly above that proposed by Vollenweider (1975) as a "eutropic" loading (see page 17). Since the industrial wastes from the town of Sulphur have been diverted, nutrient loading to the reservoir has probably

been reduced as much as is possible unless nonpoint sources or other unknown contributions from the city of Sulphur prove to be controllable.

Any addition to the existing phosphorus loading of this lake should be carefully evaluated in order to maintain its present high water quality.

2. Nonpoint sources -

The phosphorus contributions of nonpoint sources accounted for 100% of the load to Arbuckle Lake. Rock Creek contributed 28.9%, Guy Sandy Creek contributed 27.2%, and ungaged tributaries were estimated to have contributed 39.6%.

The phosphorus exports of the two tributaries (Section IV-D) impacting Arbuckle Reservoir were somewhat higher than the rates of tributaries in nearby Texoma Lake (in press); e.g. Washita River (4 kg P/km^2/yr) and Sandy Creek (7 kg P/km^2/yr).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area and mean depth were provided by the Oklahoma Department of Pollution Control; maximum depth was provided by the Oklahoma Water Resources Board. Tributary flow data were provided by the Oklahoma District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 9.51 km^2.
2. Mean depth: 9.4 meters.
3. Maximum depth: 28.6 meters.
4. Volume: 89.394 x 10^6 m^3.
5. Mean hydraulic retention time: 1,176 days (3.2 yrs).

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area(km^2)	Mean Flow (m^3/sec)
A-2 Rock Creek	101.8	0.42
B-1 Guy Sandy Creek	89.1	0.36
Minor tributaries and immediate drainage -	126.0	0.56
Totals	316.9	1.34
2. Outlet - A-1 Rock Creek	326.3	0.88

C. Precipitation:

1. Year of sampling: 110.9 cm.
2. Mean annual: 96.2 cm.

III. LAKE WATER QUALITY SUMMARY

Arbuckle Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from four stations on the lake (Station 01 was only sampled twice) and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 24.4 meters at Station 01, 8.5 meters at Station 02, 6.1 meters at Station 03, and 14.6 meters at Station 04. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

[redacted]

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		[redacted]					[redacted]					[redacted]				
		[redacted]					[redacted]					[redacted]				
[redacted]		[redacted]					[redacted]					[redacted]				
[redacted]																
[redacted]																
[redacted]											

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/30/74	1. Melosira	11,759
	2. Chroomonas	450
	3. Cyclotella	450
	4. Cryptomonas	250
	5. Scenedesmus	200
	Other genera	451
	Total	13,560
06/12/74	1. Melosira	478
	2. Pediastrum	191
	3. Cryptomonas	143
	4. Anabaena	95
	5. Mougeotia	95
	Other genera	207
	Total	1,209
10/23/74	1. Melosira	196
	2. Oocystis	164
	3. Scenedesmus	146
	4. Anabaena	98
	5. Chroomonas	98
	Other genera	558
	Total	1,060

8. Chlorophyll A -

Sampling Date	Station Number	Chlorophyll A (ug/l)
03/30/74	01	10.2
	02	11.5
	03	12.6
	04	****
06/12/74	01	2.4
	02	3.7
	03	2.3
	04	2.5
10/23/74	01	7.2
	02	9.2
	03	9.1
	04	6.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum Yield (mg/l-dry wt.)
a. 03/30/74			
Control	0.005	0.042	0.2
0.05 P	0.055	0.042	2.2
0.05 P + 1.0 N	0.055	1.042	22.0
1.00 N	0.005	1.042	0.1
b. 10/23/74			
Control	0.013	0.050	0.3
0.05 P	0.063	0.050	1.5
0.05 P + 1.0 N	0.063	1.050	16.7
1.00 N	0.013	1.050	0.3

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary productivity in Arbuckle Lake was low during both March and October samplings. In both assays, there was a significant increase in yield over that of the control when orthophosphorus was added but a lack of yield response when nitrogen alone was added. The maximum increase in yield over that of the control was achieved with the simultaneous addition of both nutrients. Based on these results, phosphorus limitation is indicated. However, it should be noted that there were substantial changes in

nutrient levels between the collection and assay of the water samples. Therefore, the assay may not accurately reflect the nutrient limitation situation in the lake at the time of collection.

N/P ratios in the lake data were 10/1 and less than 11/1 in March and October, respectively, suggesting primary limitation by nitrogen in Arbuckle Lake, and 15/1 in June, suggesting phosphorus limitation at that time (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Oklahoma National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of May when two samples were generally collected. Sampling was begun in November 1974, and was completed in October 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oklahoma District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $kg/km^2/yr$ in Guy Sandy Creek, at Station B-1, and multiplying the means by the ZZ area in km^2.

A. Waste Sources:

1. Known municipal - None
2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Rock Creek	1,100	28.9
B-1 Guy Sandy Creek	1,036	27.2
b. Minor tributaries and immediate drainage (nonpoint load) -	1,510	39.6
c. Known municipal STP's - None		
d. Septic tanks - None		
e. Known industrial - None		
f. Direct precipitation* -	165	4.3
Totals	3,810	100.0
2. Output - A-1 Rock Creek	885	
3. Net annual P accumulation -	2,925	

*Estimated (see NES Working Paper No. 175).

B. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Rock Creek	12,480	20.4
B-1 Guy Sandy Creek	16,920	26.9
b. Minor tributaries and immediate drainage (nonpoint load) -	22,555	36.8
c. Known municipal STP's - None		
d. Septic tanks - None		
e. Known industrial - None		
f. Direct precipitation* -	10,265	16.8
Totals	61,220	100.0
2. Output - A-1 Rock Creek	28,905	
3. Net annual N accumulation -	32,315	

*Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Rock Creek	11	123
Guy Sandy Creek	12	179

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
C-1 Buckhorn Creek	0.106	1.403

Nutrient levels for tributary C-1, Buckhorn Creek, are equivalent to those found in the two gaged tributaries flowing into Arbuckle Lake.

F. Yearly loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Arbuckle Lake	0.40
Vollenweider's "eutrophic" loading	0.33
Vollenweider's "oligotrophic" loading	0.17

V. LITERATURE REVIEWED

Vollenweider, R. A. 1975. Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

[redacted]

[redacted] Flow Information For [redacted]

[redacted]

[redacted] Monthly Flows and Daily Flows(cfs)

[redacted]	[redacted]	[redacted]	[redacted] Flow	Day	Flow	Day	Flow	Day	Flow
[redacted]	11	34	2,963	25	8,207				
	12	34	8,178	26	8,198				
	1	35	8,260	27	8,342				
	2	35	8,456	11	8,463				
	3	35	1,876	13	1,884				
	4	35	1,726	4	1,975				
	5	35	2,302	3	8,345	12	8,595		
	6	35	2,237	11	5,739				
	7	35	1,859	16	8,242				
	8	35	8,394	9	8,595				
	9	35	8,185	6	8,825				
	10	35	8,193	28	8,811				
[redacted]	11	34	1,446						
	12	34	8,254						
	1	35	8,425						
	2	35	1,446						
	3	35	1,404						
	4	35	1,374						
	5	35	3,543						
	6	35	3,389						
	7	35	1,667						
	8	35	8,823						
	9	35	8,279						
	10	34	8,241						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

[illegible]

[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	GAMMA RAY API UNITS	DEPTH CORRECTION FEET	RADIOACTIVE TRACER USED (SPECIFY)
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	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	3.7	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		1.7
	[illegible]	[illegible]	[illegible]		
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	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	4.7	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		1.7
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		

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[redacted]

DATE	TIME	DEPTH	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	FEET	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		12.5	
[redacted]	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	2.3	
	[redacted]	[redacted]			98.0
	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]			1.1
	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	4.1	
	[redacted]	[redacted]			98.0
	[redacted]	[redacted]	[redacted]		
	[redacted]	[redacted]			1.1
	[redacted]	[redacted]	[redacted]		

[illegible] [illegible] [illegible]

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[illegible]
36 25 33.0 [illegible] 39 57.6)
[illegible]
48 [illegible]

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		TEMP		SECCHI	FIELD			CACO3	TOTAL	D	[illegible]
TO	DAY	FEET	CENT	MG/L	[illegible]	[illegible]	SU	MG/L	MG/L	MG/L	MG/L	MG/L P
[illegible]	13	40	[illegible]	21.1	8.4		7L	425	8.60	156	1.040	0.600	0.030	0.004
	13	40	[illegible]	20.7	6.4			425	8.60	156	1.030	0.600	0.040	[illegible]
	13	40	[illegible]	25.0	7.0			426	8.70	159	1.030	0.500	0.040	0.004
	13	40	[illegible]	25.1	5.4			429	8.50	162	1.030	0.500	0.030	0.010
	13	42	[illegible]	24.2	5.4			369	8.20	174	1.106	0.400	0.140	0.007
[illegible]	11	45	[illegible]	18.9	7.2		7H	371	7.47	153	1.040	0.500	0.050	0.006
	11	45	[illegible]	19.4	7.6			371	7.48	153	1.030	0.400	0.050	0.004
	11	45	[illegible]	19.7	7.2			371	7.47	152	1.030	0.300	0.050	0.005
	11	45	[illegible]	19.6	6.8			371	7.47	152	1.030	0.300	0.040	0.004
	11	47	[illegible]	18.1	7.4			409	7.43	167	1.030	0.200	0.020	0.008

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		N		
TO	DAY	FEET	MG/L N	MG/L	PERCENT
[illegible]	13	40	[illegible]	2.5	
	13	40	[illegible]		
	13	42	[illegible]		1.0
	13	40	[illegible]		
	13	42	[illegible]		
[illegible]	11	45	[illegible]	1.2	
	11	45	[illegible]		5.0
	11	45	[illegible]		
	11	45	[illegible]		1.0
	11	45	[illegible]		
	11	47	[illegible]		
	11	45	[illegible]		

APPENDIX D

TRIBUTARY DATA

[illegible]

[illegible]

[illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 D-TOTAL MG/L	00625 TOT KJEL MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/25	11 30		0.040	1.000	0.020	0.010	0.010
74/12/10	09 30		0.040	0.400	0.025	0.005*	0.020
75/01/27	11 00		0.050	0.550	0.040	0.005	0.025
75/02/11	13 00		0.040	0.400	0.010	0.005*	0.030
75/03/13	10 45		0.260	0.450	0.032	0.010	0.040
75/04/08	10 30		0.070	0.250	0.020	0.005	
75/05/03	15 30		0.070	0.400	0.005	0.010	0.030
75/05/20	15 05		0.040	1.400	0.040	0.012	
75/06/11	10 25		0.045	0.500	0.020	0.010	0.050
75/07/16	14 00		0.010	0.450	0.015	0.005	0.020
75/08/07	14 00		0.005	0.100	0.005	0.005*	0.030
75/09/03	13 00		0.050	0.400	0.020	0.020	0.040
75/10/20	10 45		0.005	0.800	0.005	0.005	0.040

* VALUE KNOWN TO BE LESS THAN INDICATED

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L P	MG/L P
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	TO		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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< VALUE GIVEN IS <
LESS THAN [illegible]

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	TO		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	12	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	12	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	16	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	09	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	13	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF OKLAHOMA

[illegible]

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